Case Report

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Lingering Binocular Vision Issues after a Suspected Concussion: A Case Study

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Abstract

This case study examines long-term vision related issues after a suspected concussion. After assessments, it became apparent that the vision issues were widespread and ongoing vision therapy was conducted. A 12-month follow up revealed significant improvement in all oculomotor metrics, although the patient remained outside normative ranges.

Keywords: Binocular vision; Concussion; Eye tracking; Vision

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Introduction

Past clinical research using eye tracking with patients who have known concussions shown deficits in eye-target synchronization, smooth pursuit eye movements, velocity error and positioning errors [1,2]. Clinical assessments of suspected brain injuries include gross assessments of oculomotor abilities (such as the Vestibular Ocular Motor Screening (VOMS) [3]. However, quantitative, and highly sensitive measures are needed to identify cases that do not fit clear symptomology and/or require ongoing monitoring. Past studies have shown eye tracking as a promising tool in such cases [4]. This case study examines clinical assessments and eye tracking to monitor patient change over time after extensive vision therapy from a suspected concussion.

Case Study

A 65-year-old female presented at the Nebraska Medical Center in Bellevue on February 3rd, 2014 after a car accident 48 hours prior. The accident involved her car being hit by another car and although shaken, she did not appear to lose consciousness. A Magnetic Resonance Imaging (MRI) test and x-rays were performed. Results revealed no abnormalities.

Clinical examination by an Optometry Doctor shortly after the accident revealed binocular disparity, poor binocular coordination, eye alignment, depth perception and field of view were significantly below normative standards. Vision therapy and prisms were prescribed to correct the binocular issues. Therapy was conducted twice weekly.

On January 9th, 2016, the patient used RightEye for testing oculomotor behavior. This is a digitized, eye-tracked, form of the VOMS. The gaze trail of her eye movements can be seen **in Figure 1**. Typical gaze trail patterns, of age-related comparison, are shown in **Figure 2**.

Compared to normative data ranges the patient fell outside the norms on all oculomotor metrics **(Table 1).** Saccade: fast

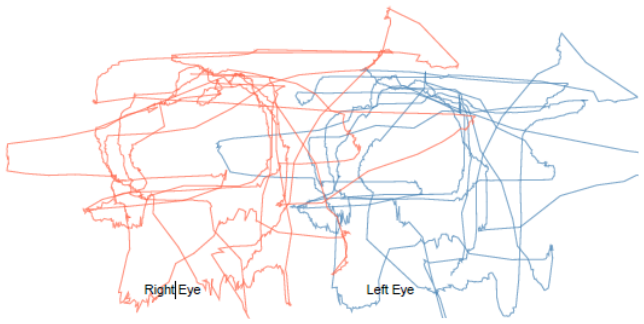

Figure 1 Patient gaze trail as of January 9th, 2016.

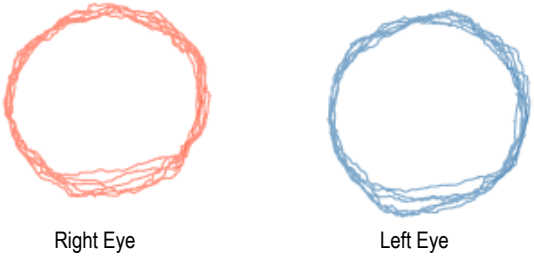

Figure 2 Typical age-related gaze trail.

eye movement. Fixation: stopping point. Smooth pursuit: eye follows target. Velocity error: error in judgement of speed. Horizontal synchronization: judgement in relation to target and X-coordinate. Vertical synchronization: judgement in relation to target and Y-coordinate. Predictive: eye in-front of target. Latent: eye behind target. On January 6th, 2017 patient was again tested using RightEye **(Figure 3 and Table 2)**. Testing showed marked improved since 2016 with all metrics moving in the direction of population norms. The predictive smooth pursuit metric increased toward population norms; however a lower number is preferred.

Table 3 shows the percentage of improvement over the 12 months between Right Eye assessments. Green shows the improved metrics in the desired direction.

Discussion

Results of this case study show ongoing oculomotor deficits compared to age-related population norms after a suspected concussion. Extensive vision therapy, improved results however, the patient continues to remain outside normal ranges.

Conclusion

This case study highlights the possible long-term effects of vision issues after a concussion, along with a quantitative method for ongoing clinical analysis.

Table 1 Patients eye movement metrics as of January 9th, 2016.

Metrics	Right eye		Left eye		Both	
	Actual	Population	Actual	Population	Actual	Population
Smooth Oursuit (%)	71.33	90 (+/-7)	67.83	90 (+/-7)	69.95	92 (+/-6)
Saccade (%)	19.84	6 (+/-5)	19.31	6 (+/-5)	18.93	5 (+/-4)
Fixation (%)	8.84	4 (+/-3)	12.86	4 (+/-3)	11.11	3 (+/-3)
Eye Target Velocity error (°)	33.27	15 (+/-2)	32.25	15 (+/-2)	33.05	15 (+/-2)
Horizontal Synchronization SP (0-1)	0.62	0.89 (+/-0.06)	0.63	0.89 (+/-0.06)	0.66	0.91 (+/-0.05)
Vertical Synchronization (0-1)	0.69	0.85 (+/-0.07)	0.67	0.85 (+/-0.07)	0.71	0.87 (+/-0.06)
Sub-Metrics	**Right eye**		**Left eye**		**Both**	
	Actual	**Population**	**Actual**	**Population**	**Actual**	**Population**
On target smooth Pursuit (%)	18.09	62 (+/-20)	9.9	64 (+/-20)	16.72	70 (+/-20)
Predictive smooth Pursuit (%)	3.28	10 (+/-10)	3.39	8 (+/-8)	1.8	6 (+/-6)
Latent Smooth Pursuit (%)	42.02	18 (+/-17)	45.23	19 (+/-17)	43.71	15(+/-15)

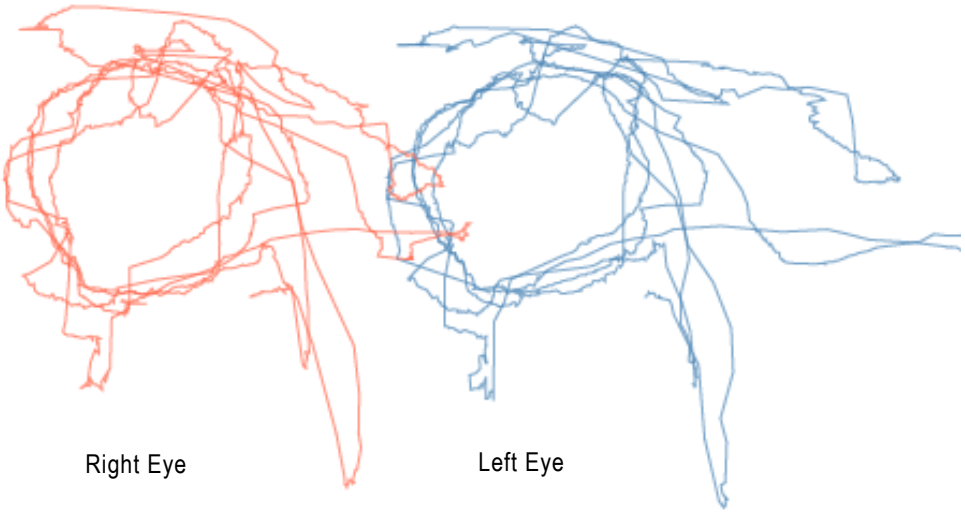

Figure 3 Patient gaze trail as of January 6th, 2017.

Table 2 Patients eye movement metrics as of January 6th, 2017.

Metrics	Right eye		Left eye		Both	
	Actual	Population	Actual	Population	Actual	Population
Smooth Oursuit (%)	76.53	90 (+/-7)	79.38	90 (+/-7)	78.22	92 (+/-6)
Saccade (%)	12.95	6 (+/-5)	13.11	6 (+/-5)	12.9	5 (+/-4)
Fixation (%)	10.52	4 (+/-3)	7.51	4 (+/-3)	8.89	3 (+/-3)
Eye Target Velocity error (°)	21.36	15 (+/-2)	22.08	15 (+/-2)	21.82	15 (+/-2)
Horizontal Synchronization SP (0-1)	0.81	0.89 (+/-0.06)	0.8	0.89 (+/-0.06)	0.81	0.91 (+/-0.05)
Vertical Synchronization (0-1)	0.79	0.85 (+/-0.07)	0.73	0.85 (+/-0.07)	0.76	0.87 (+/-0.06)
Sub-Metrics	**Right eye**		**Left eye**		**Both**	
	Actual	**Population**	**Actual**	**Population**	**Actual**	**Population**
On target smooth Pursuit (%)	47.39	62 (+/-20)	45.37	64 (+/-20)	47.44	70 (+/-20)
Predictive smooth Pursuit (%)	11.26	10 (+/-10)	10.73	8 (+/-8)	10.26	6 (+/-6)
Latent Smooth Pursuit (%)	12.7	18 (+/-17)	16.46	19 (+/-17)	14.12	15 (+/-15)

Table 3 Percentage of improvement over the 12 months between Right eye assessments.

Metrics	Right eye		Left eye		Both	
	Actual	Population	Actual	Population	Actual	Population
Smooth Oursuit (%)	↑ 5.2	90 (+/-7)	↑ 11.55	90 (+/-7)	↑ 8.27	92 (+/-6)
Saccade (%)	↑ 6.89	6 (+/-5)	↑ 6.2	6 (+/-5)	↑ 6.03	5 (+/-4)
Fixation (%)	↑ 4.11	4 (+/-3)	↑ 5.35	4 (+/-3)	↑ 2.22	3 (+/-3)
Eye Target Velocity error (°)	↑ 11.91	15 (+/-2)	↑ 10.17	15 (+/-2)	↑ 11.23	15 (+/-2)
Horizontal Synchronization SP (0-1)	↑ 0.19	0.89 (+/-0.06)	↑ 0.17	0.89 (+/-0.06)	↑ 0.15	0.91 (+/-0.05)
Vertical Synchronization (0-1)	↑ 0.1	0.85 (+/-0.07)	↑ 0.06	0.85 (+/-0.07)	↑ 0.05	0.87 (+/-0.06)
Sub-Metrics	**Right eye**		**Left eye**		**Both**	
	Actual	**Population**	**Actual**	**Population**	**Actual**	**Population**
On target smooth Pursuit (%)	↑ 29.3	62 (+/-20)	↑ 35.47	64 (+/-20)	↑ 30.72	70 (+/-20)
Predictive smooth Pursuit (%)	↑ 7.98	10 (+/-10)	↑ 7.34	8 (+/-10)	↑ 8.46	6 (+/-6)
Latent Smooth Pursuit (%)	↑ 29.32	18 (+/-17)	↑ 28.77	19 (+/-17)	↑ 29.59	15 (+/-15)

Note: Green shows the improved metrics in the desired direction.

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